Revisional notes on the *luzonica*-group of the genus *Cricula,* with the description of new taxa from Panay and Mindoro (Philippines) (Lepidoptera: Saturniidae)

Wolfgang A. Nässig[1] and Colin G. Treadaway

Dr. Wolfgang A. Nässig F.R.E.S., Entomologie II, Forschungsinstitut Senckenberg, Senckenberganlage 25, D-60325 Frankfurt am Main, Germany; wolfgang.naessig@senckenberg.de

Colin G. Treadaway F.R.E.S., Entomologie II, Forschungsinstitut Senckenberg, Senckenberganlage 25, D-60325 Frankfurt am Main, Germany; colin.treadaway@web.de

Abstract: Revisional notes on the *luzonica*-group *s. str.* of the genus *Cricula* Walker, 1855, confined to the Philippines, are published. Based on long series studied (genitalia and external morphology as well as mtDNA-COI barcode data), the former subspecies *leyteana* Nässig & Treadaway, 1997 (on Leyte) and *kareli* Nässig & Treadaway, 1997 (on Mindanao) are raised to full species status (**stat. n.**); consequently, *C. luzonica* Jordan, 1909 (**stat. rev.**) from Luzon is also treated again as a separate species. A new species from Mindoro (*C.* ***halconensis*** **sp. n.**) and a new subspecies from Panay (*C. leyteana* ***bayani*** **ssp. n.**) are described (male holotypes in SMFL, Frankfurt am Main). Two specimens from Negros recently discovered in CSNB evidently also belong into this complex. The new taxa and their male genitalia, the barcode results and the distribution are illustrated. The possible phylogenetic relationships of these Philippine species to three Indonesian species (from the Lesser Sunda Islands) indicated by the barcode data (i.e., the *luzonica*-group *s. l.*) and further continental taxa are discussed.

Key words: Bombycoidea, Luzon, Leyte, Negros, Mindanao, Flores, Alor, Timor.

Anmerkungen zu einer Revision der *luzonica*-Gruppe der Gattung *Cricula* mit der Beschreibung neuer Taxa von Panay und Mindoro (Philippinen) (Lepidoptera: Saturniidae)

Zusammenfassung: Anmerkungen zu einer Revision der *luzonica*-Gruppe *s. str.* der Gattung *Cricula* Walker, 1855, von den Philippinen werden publiziert. Basierend auf der Untersuchung langer Serien (sowohl in Genitalmorphologie und Habitus wie auch im mtDNA-COI-Barcode) werden die früheren Unterarten *leyteana* Nässig & Treadaway, 1997 (von Leyte) and *kareli* Nässig & Treadaway, 1997 (von Mindanao) in Artrang erhoben (**stat. n.**); daraus folgt, daß auch *C. luzonica* Jordan, 1909 (**stat. rev.**) von Luzon wieder als separate Art betrachtet wird. Eine neue Art von Mindoro (*C.* ***halconensis*** **sp. n.**) und eine neue Unterart von Panay (*C. leyteana* ***bayani*** **ssp. n.**) werden beschrieben (männliche Holotypen in SMFL, Frankfurt am Main). Zwei erst kurz vor Drucklegung in CSNB aufgefundene Exemplare von Negros gehören gleichfalls in diesen Komplex. Die neuen Taxa und die männlichen Genitalien werden abgebildet. Die möglichen Verwandtschaftsbeziehungen dieser philippinischen Arten zu drei indonesischen Arten (von den Kleinen Sundainseln) (also der *luzonica*-Gruppe *s. l.*), die im Barcodeergebnis angedeutet werden, sowie zu weiteren kontinentalen Arten werden diskutiert.

Introduction

In 1998, we published a monograph on the Saturniidae of the Philippines (Nässig & Treadaway 1998). Recently, contributions to the *elaezia* species-group (and some others) of the genus *Cricula* Walker, 1855 were published (Naumann & Löffler 2010, Brechlin 2010, Nässig et al. 2010), which in part also dealt with the single Philippine member of that group (i.e., *C. mindanaensis* Nässig & Treadaway, 1997: see Nässig & Treadaway *in* Nässig et al. 2010).

Since the publication of Nässig & Treadaway (1998), new data were also accumulated on the *luzonica*-group of the genus *Cricula,* which will be dealt with here. Further, recent publications (Naumann & Löffler 2010, Naumann & Lane 2010) based on barcode studies conducted in the laboratories of the "Canadian Centre for DNA Barcoding" (CCDB) in Guelph, Ontario (Canada), added new (and somehow surprising) species to the *luzonica*-group of *Cricula*. According to the barcode similarities (and supposing that there really is some sort of a phylogenetic signal contained within this character at the low level of a species-group), the species

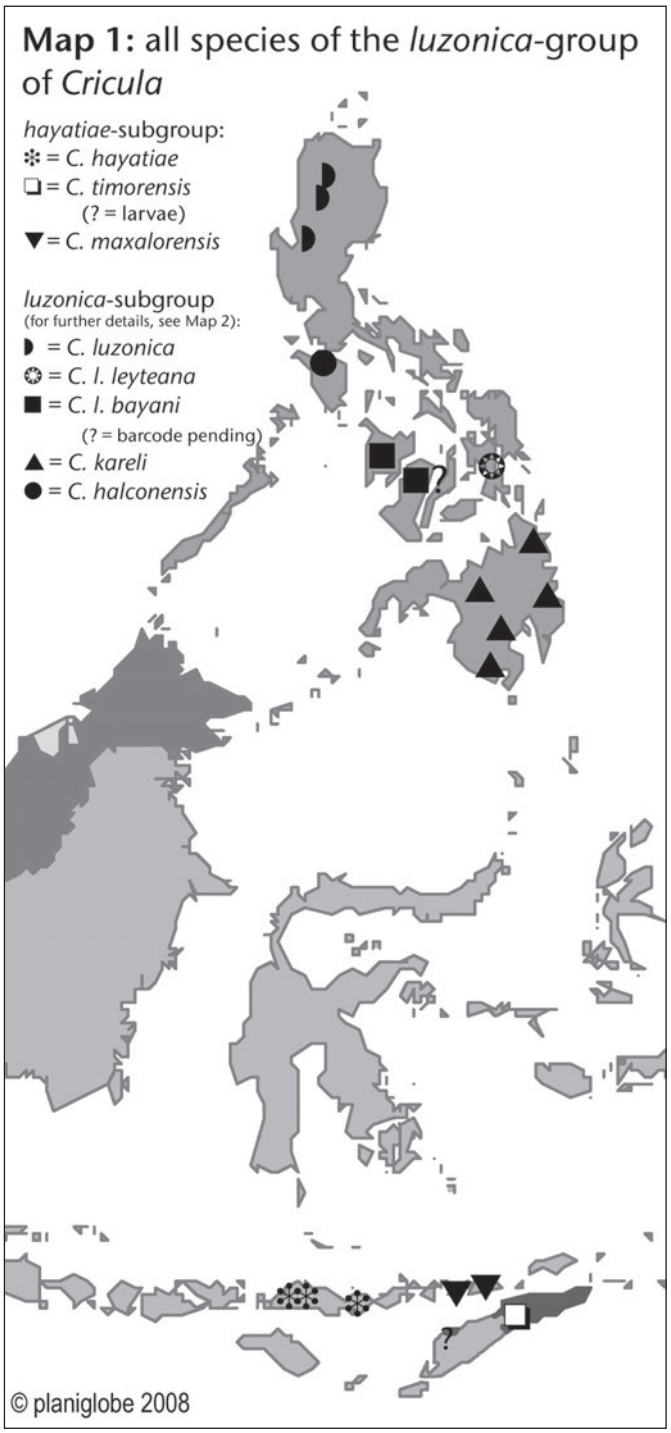
- *Cricula hayatiae* U. Paukstadt & Suhardjono, 1992,
- *Cricula maxalorensis* Naumann & Löffler, 2010 and
- *Cricula timorensis* Naumann & Lane, 2010

also appear to belong to the *luzonica* species-group, although they are geographically widely separate from their supposed Philippine relatives (see Map 1). This was really a surprise, and it was thus understandable that U. & L. H. Paukstadt (2010: 61) doubted this result (see Nässig et al. 2010: 150). However, the evidence is perhaps a bit more convincing than expected by U. & L. H. Paukstadt, see below.

When the third "Special Philippine Issue" within the Supplementa series of NEVA containing the treatment of the Saturniidae of the Philippines (Nässig & Treadaway 1998) was published in July 1998, there had already been collected a small series of specimens of *Cricula* Walker, 1855 on Panay in June 1998 which were sent to us later in autumn 1998 by a local collector. Immediately on arrival it became clear that these 4 ♂ specimens (at that time the first *Cricula* specimens known to us from Panay at all) were at least a new and slightly surprising island record for the *luzonica*-group, and a dissection soon revealed that the Panay population necessitated further studies on the entire *luzonica*-group. Further specimens, also from other areas of Panay, were received later (see below). Another specimen received from Mindoro in 2003 and evidently also belonging to the *luzonica*-group further complicated the situation.

[1] 78th contribution to the knowledge of the Saturniidae. (77th contribution: Nässig, W. A., Naumann, S., & Rougerie, R. (2010): Evidence for the existence of three species in the genus *Archaeoattacus* (Lepidoptera: Saturniidae). — Journal of Research on the Lepidoptera, Arcadia, Calif., **43:** 37–47.)

© Entomologischer Verein Apollo e. V., Frankfurt am Main



Map 1: The species of the *luzonica*-group *sensu lato* of the genus *Cricula;* all known species from Indonesia and the Philippines included. — One symbol may stand for more than one locality in close proximity. — Basis of Map 1 from www.planiglobe.com, modified.

Morphological studies alone, however, were not satisfactory enough to publish the results at that time, and so, since 2009, we applied the new method of DNA barcoding, basically based on a short sequence of 648 base pairs of the mitochondrial DNA of the cytochrome-*c* oxydase, subunit I, gene (COI), extracted from legs of dried specimens mainly from the collections CWAN, CCGT, SMFL, CSNB, CSKK, CSLL submitted to Canada (see Figs. 1a, 1b). Just before print of the present paper, further information on a member of the *luzonica*-group from Negros was received; the barcode results of these two specimens are not yet available.

Abbreviations and conventions see in Nässig & Treadaway (1998) and Naumann & Nässig (2010); addition: CSKK = coll. Steve Kohll, Kayl, Luxembourg. General information on barcoding see in the web (Barcode of life 2010). Technical details of extraction and amplification and sequencing protocols can be found on the CCDB website (CCDB 2010) and are also described in, e.g., Ratnasingham & Hebert (2007) or Vaglia et al. (2008).

Revisional notes on the *luzonica*-group of the genus *Cricula* (the species of the Philippines)

History

The *luzonica*-group was defined by Nässig (1995: 43) mainly on basis of the ♂ genitalia (terminology following Roepke 1940) by the following supposed synapomorphies: shape of the sella (rather long, round, rather thin, tip not bifurcate except in *kareli*), shape of the „wings" of the collare (rounded, ear-like), vesica bilobed, cornuti reduced; further on basis of external morphology: a special mixture of orange and brown scales on the wings and (in part) similarities in the fw. pattern: the "blind" fw. eyespots are often (not always) with a darker greyish outer ring, filled with a brighter greyish (sometimes nearly whitish) centre. Not all of these group characters were confirmed by the new taxa described here.

Before the results of Stefan Naumann on *C. hayatiae* and related new species were published (Naumann & Löffler 2010, Naumann & Lane 2010) and before these new specimens from Panay and Mindoro were collected and studied, we (Nässig 1995, Nässig & Treadaway 1997, 1998) interpreted the situation in the *luzonica*-group of the genus *Cricula* Walker, 1855 as follows: There is one species, *Cricula luzonica* Jordan, 1909, found in three different subspecies along the eastern Philippine islands (see Maps):

- *luzonica* in the North on Luzon,
- *leyteana* Nässig & Treadaway, 1997 in the South-East on Leyte and
- *kareli* Nässig & Treadaway, 1997 in the South on Mindanao.

Within the Philippines, the status of *kareli* appeared to be most distinct at the time of description, and we already noted slight, but visible and evidently stabile differences in ♂ genitalia and external morphology between all three populations (Nässig & Treadaway 1997, 1998). However, at that time we hesitated to separate the three populations on specific level.

Now, with the new material from Panay, Negros and, especially, Mindoro before us and after having dissected more specimens, and after receiving the results of the barcode studies, we interprete the situation within the Philippines differently.

The differences in habitus and genitalia morphology are constant and obvious (assessed on the long series at our disposal in CCGT, CWAN and SMFL of all three taxa known before) and were also supported by the results of the barcode analysis, so that we decided to interprete

© Entomologischer Verein Apollo e. V., Frankfurt am Main

the insular populations of the Philippines to be separate species:

Cricula luzonica Jordan, 1909, **stat. rev.** as species, in the north in the Luzon region (Luzon island) (see Näss ig 1995: specimens col.-pl. E figs. 12–14, F fig. 1; GP b&w-pl. VI fig. 3; Näss ig & Treadaway 1997: col.-pl. II figs. 7–8, GP fig. 11; Näss ig & Treadaway 1998: col.-pl. 6 figs. 35, 40, GP b&w pl. 6 fig. 19 ♂, b&w-pl. 7 fig. 26 ♀);

Cricula leyteana Näss ig & Treadaway, 1997, **stat. n.** as species, in the south-east in the Mindanao region, East Visayas subregion (Leyte island) (see Näss ig 1995: specimens col.-pl. F figs. 2–4; GP b&w-pl. VI fig. 4; Näss ig & Treadaway 1997: col.-pl. II figs. 9–12, GP fig. 12; Näss ig & Treadaway 1998: col.-pl. 6 figs. 36, 41, GP b&w pl. 6 fig. 20 ♂) and

Cricula kareli Näss ig & Treadaway, 1997, **stat. n.** as species, in the south in the Mindanao region, Mindanao subregion (Mindanao island) (see Näss ig 1995: specimens col.-pl. F figs. 5–7; GP b&w-pl. VI fig. 5; Näss ig & Treadaway 1997: col.-pl. II figs. 13–21, GP fig. 13; Näss ig & Treadaway 1998: col.-pl. 6 figs. 37–39, 42, 43, GP b&w pl. 6 fig. 21 ♂, b&w-pl. 7 fig. 27 ♀).

These areas correspond to the larger biogeographical regions of the Philippines (compare the map in Vane-Wright 1990, reprinted in Treadaway 1998); but see also below.

Descriptions of the new taxa

The new Philippine island records are described here as follows:

Cricula halconensis n. sp.

Holotype ♂: Philippines, Mindoro, Mt. Halcon, "lower slopes", xi. 2002, leg. Noël Mohagan, coll. C. G. Treadaway. Ex CCGT in SMFL. GP WAN/SMFL 1689/04, BC B3220-wn-B10, SMFL no. 4263. Fig. 2.— No paratypes.

Etymology: Named after the type locality, Mt. Halcon, Mindoro.

Here figured: ♂ OS/US Figs. 2a, b; GP ♂ Fig. 10. Barcode similarity trees Figs. 1a, b; Maps 1, 2.

Note: There is a ♂ specimen with label data: "Philippinen, N-Mindoro, Mt. Sinai, 24. iii. 1994, coll. C. G. Treadaway", BC B3220-wn-B11, in SMFL (see Fig. 3). The wing pattern and colour of this specimen very strongly reminded us of the *luzonica*-group; it was clearly not a member of the *trifenestrata*-group. It was the first specimen of the *luzonica*-group which we received with label data from "Mindoro"; however, its abdomen was already lacking on receipt (obviously destroyed by insects), so that we could not study the genitalia. When we then received the analysis of the DNA barcode of this singleton in 2010, this first impression was supported. However, in contrast, it does not show any close similarity (neither in the barcode nor in external morphology) with the single ♂ of the new species *C. halconensis* from Mindoro, but clearly falls into the variability range of *C. kareli* from Mindanao. Therefore, we firmly believe that it is a mislabelled specimen which originated from Mindanao island (see barcode similarity trees in Figs. 1a, b). The chance that there are two species of the *luzonica*-group living on the northern island Mindoro (an endemic *C. halconensis* and the southern *C. kareli*) is minimal. — We had this specimen already before us in 1998, but did not deal with it because its genitalia were lacking.

Lfw: HT ♂ 41 mm. **Antenna:** tip broken on both sides. Longest rami ca. 2.2 mm.

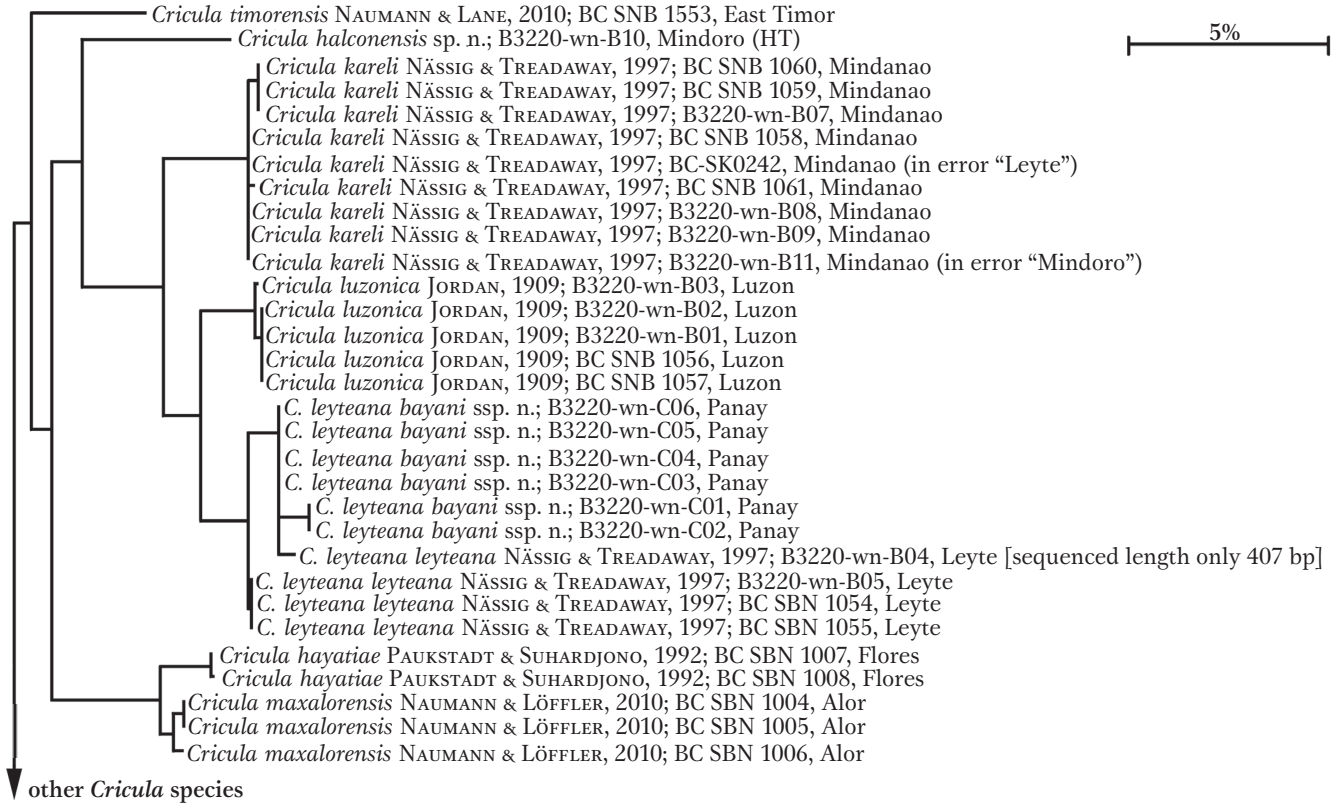
♂ (HT only), Fig. 2. Large, with 3 well-developed hyaline eyespots in the fw., the largest fenestrum being the one above the discoidal cell. Wing pattern and colours like usual for the *luzonica*-group, with orangy, purplish and brown scales; postmedian stripe especially on the hw. with some greyish shadow indicated on the outside (not well visible, probably because the specimen is already slightly worn). Marginal fields (distally of the postmedian fascia) coloured differently from the central and basal fields: fw. apical part darker, dark brown, fw. tornal part and hw. brighter. Wing shape broad, elongate. Fringes whitish. Antennae broader than in other Philippine species (see Tab. 1).

♂ **genitalia** (HT only), Fig. 10. Phallus rather stout; vesica bilobed, the two lobes slightly sclerotized, with a soft

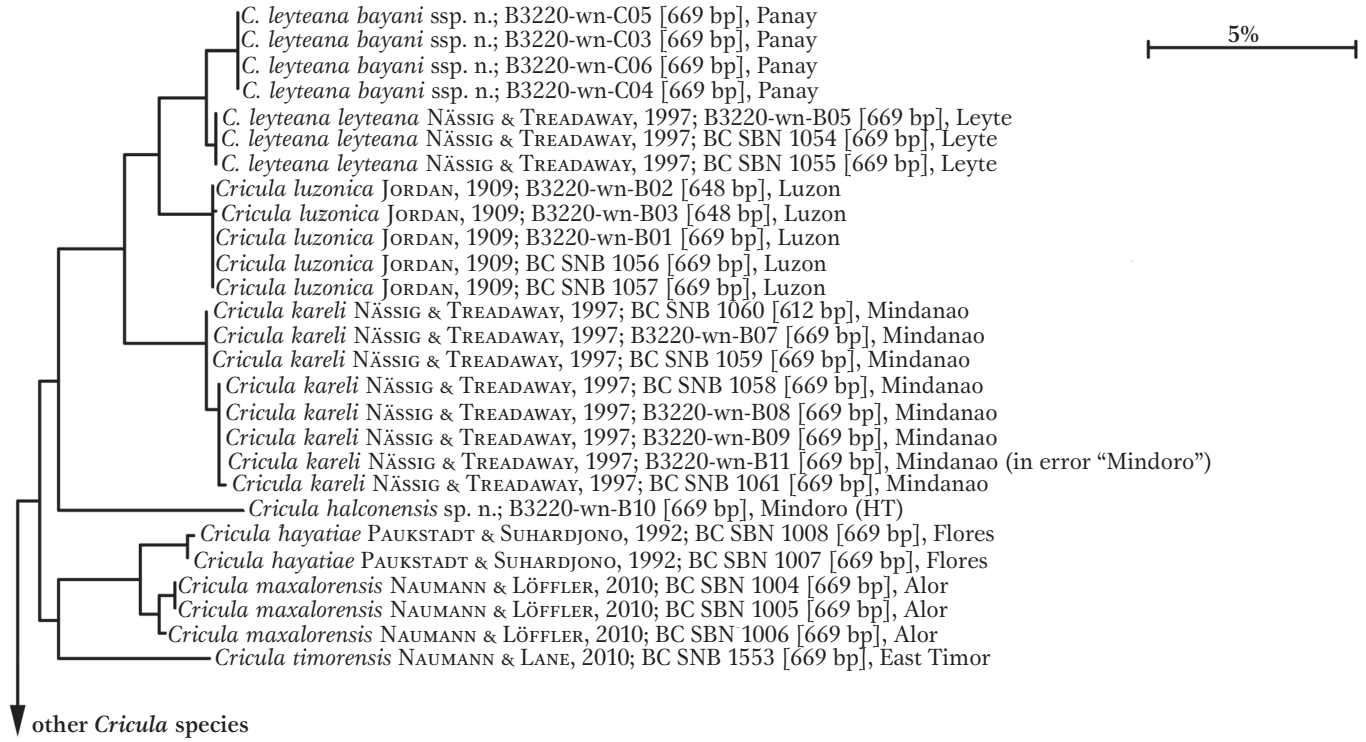
Tab. 1: Comparison of morphometric data of the taxa of the *luzonica*-group *s. l.* — Not all data available for all taxa and sexes; methods for data retrieved from literature in part different. — **Abbreviations:** Lfw.: length of forewing, measured in a straight line from the base to the apex [mm]; S.D.: one standard deviation; min.: minimum length measured [mm]; max.: maximum length measured [mm]; AL: antennal length [mm]; LR: longest rami [mm], not measured in ♀♀; S: number of segments of the antenna.

Measurements	♂♂		♀♀	
Taxon (source)	**Lfw.** (± S.D.)	**Antenna**	**Lfw.** (± S.D.)	**Antenna**
***luzonica*-subgroup**				
C. halconensis sp. n. (HT only)	41	LR: 2.2	–	–
C. luzonica (Näss ig & Treadaway 1998: 277 and specimens in SMFL)	36.0 ± 1.99 (*n* = 43), min. 32, max. 42	AL: 8–9, LR: 1.4–1.5; 23–24 S (*n* = 2)	41.7 ± 3.08 (*n* = 18), min. 35, max. 47	AL: 7–8; 26–27 S (*n* = 2)
C. l. leyteana (Näss ig & Treadaway 1998: 277 and specimens in SMFL)	39.8 ± 2.26 (*n* = 14), min. 35, max. 43	AL: 9–9.5, LR: 1.6; 23–24 S (*n* = 2)	47.6 ± 1.83 (*n* = 12), min. 45, max. 50	AL: 7–8; 24–26 S (*n* = 2)
C. l. bayani ssp. n. (type series in SMFL)	36.4 ± 3.00 (*n* = 9), min. 30, max. 40	AL: 8, LR: 1.1; 25 S (*n* = 2)	40.6 ± 2.41 (*n* = 5), min. 38, max. 44	– [broken tips or too much bent]
C. kareli (Näss ig & Treadaway 1998: 277 and specimens in SMFL)	36.1 ± 2.11 (*n* = 64), min. 31, max. 40	AL: 7, LR: 1.3–1.4; 23–24 S (*n* = 2)	44.0 ± 4.43 (*n* = 11), min. 35, max. 51	AL: 9; 23–25 S (*n* = 2)
***hayatiae*-subgroup**				
C. hayatiae (CWAN in SMFL)	34.1 ± 2.53 (*n* = 13), min. 31, max. 40	AL: 8, LR: 1.6; 23/24 S (*n* = 2)	36.8 ± 1.99 (*n* = 11), min. 33, max. 40	AL: 7; 22/24 S (*n* = 2)
C. maxalorensis (cf. Naumann & Löffler 2010)	37–40 (type series)	AL: 7.6–8.4	–	–
C. timorensis (cf. Naumann & Lane 2010)	40 (type series)	AL: 9, LR: 2.1, 26 S	–	–

© Entomologischer Verein Apollo e. V., Frankfurt am Main


5%
Cricula timorensis Naumann & Lane, 2010; BC SNB 1553, East Timor
Cricula halconensis sp. n.; B3220-wn-B10, Mindoro (HT)
Cricula kareli Nässig & Treadaway, 1997; BC SNB 1060, Mindanao
Cricula kareli Nässig & Treadaway, 1997; BC SNB 1059, Mindanao
Cricula kareli Nässig & Treadaway, 1997; B3220-wn-B07, Mindanao
Cricula kareli Nässig & Treadaway, 1997; BC SNB 1058, Mindanao
Cricula kareli Nässig & Treadaway, 1997; BC-SK0242, Mindanao (in error "Leyte")
Cricula kareli Nässig & Treadaway, 1997; BC SNB 1061, Mindanao
Cricula kareli Nässig & Treadaway, 1997; B3220-wn-B08, Mindanao
Cricula kareli Nässig & Treadaway, 1997; B3220-wn-B09, Mindanao
Cricula kareli Nässig & Treadaway, 1997; B3220-wn-B11, Mindanao (in error "Mindoro")
Cricula luzonica Jordan, 1909; B3220-wn-B03, Luzon
Cricula luzonica Jordan, 1909; B3220-wn-B02, Luzon
Cricula luzonica Jordan, 1909; B3220-wn-B01, Luzon
Cricula luzonica Jordan, 1909; BC SNB 1056, Luzon
Cricula luzonica Jordan, 1909; BC SNB 1057, Luzon
C. leyteana bayani ssp. n.; B3220-wn-C06, Panay
C. leyteana bayani ssp. n.; B3220-wn-C05, Panay
C. leyteana bayani ssp. n.; B3220-wn-C04, Panay
C. leyteana bayani ssp. n.; B3220-wn-C03, Panay
C. leyteana bayani ssp. n.; B3220-wn-C01, Panay
C. leyteana bayani ssp. n.; B3220-wn-C02, Panay
C. leyteana leyteana Nässig & Treadaway, 1997; B3220-wn-B04, Leyte [sequenced length only 407 bp]
C. leyteana leyteana Nässig & Treadaway, 1997; B3220-wn-B05, Leyte
C. leyteana leyteana Nässig & Treadaway, 1997; BC SBN 1054, Leyte
C. leyteana leyteana Nässig & Treadaway, 1997; BC SBN 1055, Leyte
Cricula hayatiae Paukstadt & Suhardjono, 1992; BC SBN 1007, Flores
Cricula hayatiae Paukstadt & Suhardjono, 1992; BC SBN 1008, Flores
Cricula maxalorensis Naumann & Löffler, 2010; BC SBN 1004, Alor
Cricula maxalorensis Naumann & Löffler, 2010; BC SBN 1005, Alor
Cricula maxalorensis Naumann & Löffler, 2010; BC SBN 1006, Alor
other Cricula species

1a


5%
C. leyteana bayani ssp. n.; B3220-wn-C05 [669 bp], Panay
C. leyteana bayani ssp. n.; B3220-wn-C03 [669 bp], Panay
C. leyteana bayani ssp. n.; B3220-wn-C06 [669 bp], Panay
C. leyteana bayani ssp. n.; B3220-wn-C04 [669 bp], Panay
C. leyteana leyteana Nässig & Treadaway, 1997; B3220-wn-B05 [669 bp], Leyte
C. leyteana leyteana Nässig & Treadaway, 1997; BC SBN 1054 [669 bp], Leyte
C. leyteana leyteana Nässig & Treadaway, 1997; BC SBN 1055 [669 bp], Leyte
Cricula luzonica Jordan, 1909; B3220-wn-B02 [648 bp], Luzon
Cricula luzonica Jordan, 1909; B3220-wn-B03 [648 bp], Luzon
Cricula luzonica Jordan, 1909; B3220-wn-B01 [669 bp], Luzon
Cricula luzonica Jordan, 1909; BC SNB 1056 [669 bp], Luzon
Cricula luzonica Jordan, 1909; BC SNB 1057 [669 bp], Luzon
Cricula kareli Nässig & Treadaway, 1997; BC SNB 1060 [612 bp], Mindanao
Cricula kareli Nässig & Treadaway, 1997; B3220-wn-B07 [669 bp], Mindanao
Cricula kareli Nässig & Treadaway, 1997; BC SNB 1059 [669 bp], Mindanao
Cricula kareli Nässig & Treadaway, 1997; BC SNB 1058 [669 bp], Mindanao
Cricula kareli Nässig & Treadaway, 1997; B3220-wn-B08 [669 bp], Mindanao
Cricula kareli Nässig & Treadaway, 1997; B3220-wn-B09 [669 bp], Mindanao
Cricula kareli Nässig & Treadaway, 1997; B3220-wn-B11 [669 bp], Mindanao (in error "Mindoro")
Cricula kareli Nässig & Treadaway, 1997; BC SNB 1061 [669 bp], Mindanao
Cricula halconensis sp. n.; B3220-wn-B10 [669 bp], Mindoro (HT)
Cricula hayatiae Paukstadt & Suhardjono, 1992; BC SBN 1008 [669 bp], Flores
Cricula hayatiae Paukstadt & Suhardjono, 1992; BC SBN 1007 [669 bp], Flores
Cricula maxalorensis Naumann & Löffler, 2010; BC SBN 1004 [669 bp], Alor
Cricula maxalorensis Naumann & Löffler, 2010; BC SBN 1005 [669 bp], Alor
Cricula maxalorensis Naumann & Löffler, 2010; BC SBN 1006 [669 bp], Alor
Cricula timorensis Naumann & Lane, 2010; BC SNB 1553 [669 bp], East Timor
other Cricula species

1b

Fig. 1a: Neighbor Joining (NJ) tree ("BOLD TaxonID Tree" = sequence similarity tree, distance model: Kimura 2 parameter [K2P]) of the *luzonica* species-group of *Cricula*. Extracted from a complete tree of the subfamily Saturniinae (comprising all genera and also all *Cricula* available) downloaded on 29. I. 2010; all sequence data with > 200 bp analysed (standard parameter) included (= 31 samples). — **Fig. 1b:** NJ tree (K2P) downloaded on 21. X. 2010; only the genus *Loepa* was used as extrageneric outgroup, *Cricula* species other than members of the *luzonica*-group were only partially included, and only sequence data > 500 bp were used (= 27 samples; the 10 months difference between the calculation of the two trees also result in a few additions to the later tree). — Legends in Figs.: actual name of taxon, BC code no. [number of base pairs (bp) sequenced; these numbers are often higher than only 648 bp], locality of origin, [comment where necessary].

© Entomologischer Verein Apollo e. V., Frankfurt am Main

cornutus at the top of one lobus. Sella quite short, broad, with two tips; wings of the collare triangular and short. Valves narrow, delicate; harpe (sacculus) and dorsal lobe well-defined and apically over a long distance separated.

♀ **and biology** unknown.

Diagnosis

The new species *C. halconensis* is a larger one within the group (compare Tab. 1); its antennal rami are very long, nearly twice as long as in the other species of the *luzonica*-subgroup. Also the forewing length is remarkably large (of course, as long as only the single HT is known, nothing can be said about differences in the averages). Regarding the barcode similarity tree (Figs. 1a, b), it appears to be the external outgroup (sistergroup) of the species of the *luzonica*-subgroup. The largest fw. fenestrum is the one above the cell closest to the costa, different from the average of most other species in the subgroup where it is the one in the discoidal cell.

The new species is recognized (this diagnosis based on one specimen only) by the broad antennae, the wing-shape, the shape, size and placement of the wing fenestra; also genitalia morphology and the DNA barcode identify this species clearly.

Regrettably we did not receive further specimens of this new species so far. Describing a new species after a singleton is often a risk; but here in this case, external morphology, genitalia and barcode show identical results and offer sufficient characters to distinguish this taxon; there is no indication in the barcode that *C. halconensis* could be based on a mislabelled specimen (compare note above!), see Figs. 1a–b. (In all NJ trees calculated, not only in those shown in Figs. 1a–b, *C. halconensis* keyed out within the *luzonica*-group as sistergroup to the *luzonica*-subgroup, with usually over 5% distance; it never changed its position and never moved to the *hayatiae*-subgroup or to any continental species.)

*Cricula leyteana **bayani*** **n. ssp.**

Holotype ♂: Philippines, Panay, nr. Iloilo, Mt. Balo [= Bulac, Buloq], 25. VI. 1998, leg. F. Mohagan, coll. C. G. Treadaway. Ex CCGT in SMFL. BC B3220-wn-C01. SMFL no. 4180. Fig. 4.

Paratypes (13 ♂♂, 5 ♀♀), all **Philippines, Panay:** 3 ♂♂, same locality as HT, data: 20., 21., 25. VI. 1998 (GP nos. 1216/98, 1217/98, 1688/04 WAN in SMFL), SMFL nos. 4181–4183. 3 ♂♂, 4 ♀♀, 10 km from/near Iloilo, Tubungan, 100 m, 15. III. 2000 (2 ♂♂; BC B3220-wn-C06), 16. III. (2 ♀♀; GP 1461/01 WAN in SMFL, Fig. 12), 17. III. (1 ♀), 29. III. (1 ♂, 1 ♀; BC ♂ B3220-wn-C05, Fig. 7), SMFL nos. 4255–4261. 1 ♂, 1 ♀, Panay, Antique, Mt. Madja-as, 18. XII. [♂], 20. XII. [♀] 1999 (BC ♀ B3220-wn-C04, Fig. 6), SMFL nos. 4185–4186. 1 ♂, Antique, Mt. Madja-as, 600 m, 3. III. 2000, GP 1460/01 WAN in SMFL, SMFL no. 4187, Figs. 5, 11. 1 ♂, Mt. Banag, 20.–25. II. 2001, GP 1686/04, BC B3220-wn-C03, SMFL no. 4262. All leg. local collector[s], ex CCGT in SMFL. – 3 ♂♂, Antique, Mt. Culasi, 800 m, III. 2001, leg. N. Mohagan, CSLL. 1 ♂, Mt. Madja-as, 1300 m, I. 2003, leg. Ida Fierro, CSLL. – A ♂ PT ex SMFL will be donated to S. Naumann for his support.

Further material, no PTs: 2 ♂♂, Negros, Mt. Canlaon, X. 2007, leg. local collector, via A. Saldaitis in CSNB, BC SNB 2147–2148, GP SNB 2219/10–2220/10 (Figs. 8–9, 13). – These two specimens turned up only a short time before the present publication went to the printer. Legs of the two were sent to Guelph to get the barcode analysis, but, of course, the results are not yet available. Based on zoogeographical reasoning, we expect that they will turn out to be closely related to *C. leyteana bayani* from the neighbouring (and biogeographically close) Panay island. ♂ genitalia are quite similar, but show some minor differences.

Etymology: Named after Bayani Lumawig for his contribution to the study of Philippine Lepidoptera. The name is a noun in apposition.

Here figured: ♂ OS/US Figs. 4–5, 7; ♀ Fig. 6; GP ♂ Fig. 11, ♀ Fig. 12. Barcode similarity trees Figs. 1a, b; Maps 1, 2.

Distribution: The new subspecies is known only from Panay and, possibly, Negros, West Visayan region, so far.

Lfw: HT 38 mm, ♂♂ average 36.4 mm ± 3.00 S.D. (n = 9 inkl. HT), min. 30 mm, max. 40 mm; ♀♀ average 40.6 mm ± 2.41 S.D. (n = 5), min. 38 mm, max. 44 mm. **Antenna:** HT ♂ length ca. 8 mm; longest rami ca. 1.1 mm; ca. 25 segments. All based on Panay specimens. – 2 ♂♂ Negros: Lfw. 35/36 mm (n = 2). – For comparison to other species, see Tab. 1.

♂, Figs. 4–5, 7. Most specimens more or less orangy brown, some a bit darker. Usually only one fenestrum on every wing; on fw. at least one more indicated by a greyish-violet dot, the one on the hw. sometimes only indicated or with very small hyaline centre. Marginal fields (distally of the postmedian fascia) coloured differently from the central and basal fields: fw. apical part darker, fw. tornal part with an often very bright patch and hw. anal part generally with a different tone (more dark scales mixed under the bright ones).

♂ **genitalia,** Fig. 11. Closely resembling those of *C. leyteana leyteana*.

♀, Fig. 6. Ground colour orangy brown. Fenestra with some greyish-violet framing. 3 fenestra of the fw. well-developed, a few more indicated by greyish-violet patches. Fenestrum on hw. round, relatively large. Tornal part of fw. and anal part of hw. with a greyish-violet patch.

♀ **genitalia,** Fig. 12. Similar to those of *C. leyteana leyteana*.

Diagnosis

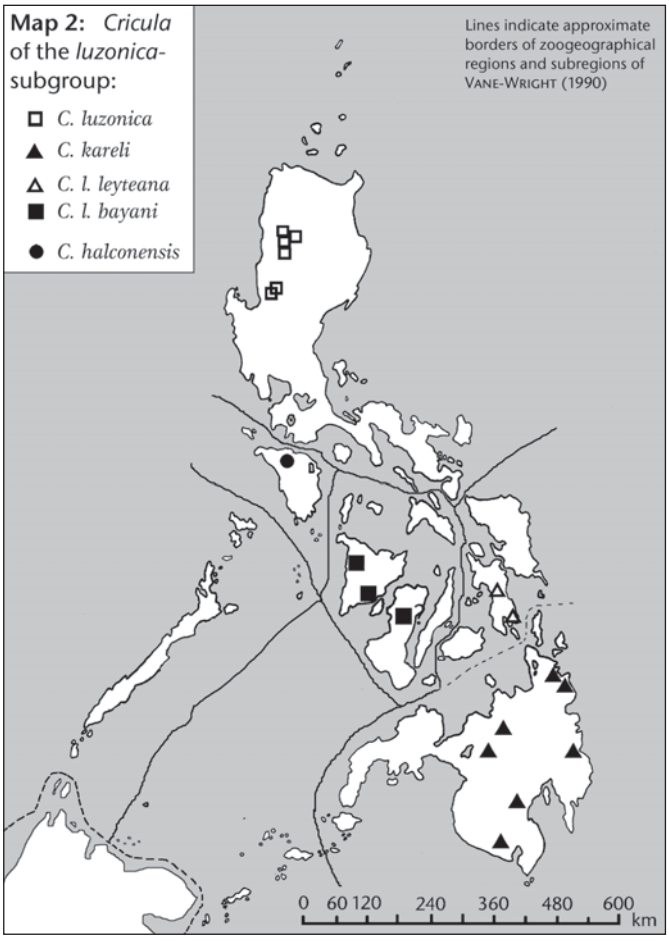
The new subspecies from Panay is a small one in the subgroup, close in size to *C. luzonica* and *C. kareli,* and with a rather high variability in lfw. (highest standard deviation within the group, see Tab. 1). In both sexes of *C. leyteana bayani* (Panay population), it is remarkable that the hw. fasciae on both sides of the discoidal patch (i.e., antemedian and postmedian lines) have a strong tendency to approach and meet confluently above the cell, before breaking off again and independently merging into the costal margin of the hw. (like the letter X). This pattern element is rarely also seen in other taxa of the *luzonica*-subgroup, but it can be found in almost all specimens of *C. l. bayani* (15 of 19 specimens of the type series have at least a confluent approach or a full merging and splitting up again of the two lines). *C. leyteana*

© Entomologischer Verein Apollo e. V., Frankfurt am Main

bayani has only ca. 1% barcode distance to the nominotypical subspecies, but about 2% to *C. luzonica* and even more to *C. kareli* (Fig. 1b).

Distribution patterns and zoogeography in the Philippines

The probable close phylogenetic proximity of the *Cricula* of the *luzonica*-group from Leyte and Panay as indicated by morphology and the DNA barcode results is slightly surprising, compared to Vane-Wright's (1990) maps of the biogeographic regions and subregions of the Philippines, which were mainly based on biogeographical data of butterflies and the exposed land above sea level during the pleistocene, as based on the current 120 m bathymetric line (see Vane-Wright 1990: 24–26). According to Vane-Wright, the East Visayan subregion (to which Leyte belongs) is part of the larger Mindanao region, while the West Visayan islands (to which Panay and Negros belong) form a separate region of their own. However, as the phylogenetic and migratory history of different organisms never is necessarily identical in all details, this should, in fact, not be too surprising. And Saturniidae (with their rather poor abilities to colonize across barriers due to their reduced and unfunctional proboscis) in general perhaps exhibit older distribution patterns than more mobile species like, e.g., butterflies.


Map 2: Cricula of the luzonica-subgroup:
C. luzonica
C. kareli
C. l. leyteana
C. l. bayani
C. halconensis
Lines indicate approximate borders of zoogeographical regions and subregions of Vane-Wright (1990)
0 60 120 240 360 480 600
km

Map 2: Distribution of the taxa of the *luzonica*-subgroup of the *luzonica*-group of the genus *Cricula* on the Philippines. — ? = barcode results for the Negros specimens pending. — From Nässig & Treadaway (1998), modified and supplemented.

Discussion of the *luzonica*-group

Barcode and Neighbor Joining similarity trees

We illustrate two different NJ trees based on the barcode analyses (Figs. 1a, 1b) here. The first one (1a) is based on a tree of all Saturniinae with sequence lengths > 200 bp, calculated by the BOLD website on 29. I. 2010; the second (1b) was calculated on 21. X. 2010 and is based on all *luzonica*-group specimens, a selected series of other *Cricula* species (including all major species-groups) and *Loepa* as outgroup and based on sequence lengths > 500 bp. So the second variant (Fig. 1b) is the more reliable similarity tree. The structural differences between the two trees are few and do not concern the *luzonica*-subgroup; the main difference can be found in the relation between the *hayatiae*- and the *luzonica*-subgroups.

The *luzonica* [*s. str.*]-subgroup on the Philippines

The new results widen the range of the *luzonica*-group within the Philippines; Mindoro, Panay and Negros were not known to be inhabited by the *luzonica*-group before. (For the identity of the two Negros specimens and an analysis of the distribution pattern within the Visayas we must wait for further barcode results.)

For an ecological comparison of elevation and flight period data of the formerly known 3 [sub-]species of the *luzonica*-subgroup, see the tables 18 & 19 in Nässig & Treadaway (1998: 278). For the new species, see the data above in the type lists.

The *luzonica*-subgroup is now found to be a widespread endemic inhabitor of the Philippine archipelago (probably except Palawan) and may also be found on further islands when adequate studies are conducted.

The supposed new Indonesian members of the *luzonica*-group [*s. l.*]

According to Naumann & Löffler (2010), the following species also appear to belong to the *luzonica*-group of the genus *Cricula*:

Cricula hayatiae Paukstadt & Suhardjono, 1992 (Flores)

Cricula maxalorensis Naumann & Löffler, 2010 (Alor)

Cricula timorensis Naumann & Lane, 2010 (Timor)

(For some ecological, preimaginal and variability data on *C. hayatiae,* compare Paukstadt & Paukstadt 1992, 1993a, 1993b, 1995.)

The inclusion of these three Indonesian species from the Lesser Sunda Islands is rather surprising. This interrupted ("bipolar") distribution pattern is strange (even for mountain species like those involved here), and, therefore, we should perhaps provide some further information (and speculation) why we think that this is probably representing a natural relationship, in spite of the distribution:

© Entomologischer Verein Apollo e. V., Frankfurt am Main

- It is not only the barcode which supports the inclusion of the Indonesian species into the *luzonica*-group: While the ♂ genitalia differ markedly in the phallus and especially the vesica structures, the shape of the valves, in contrast, is very similar (compare to figs. 9–12 in Naumann & Lane 2010) for the two subgroups and different from most other *Cricula* (except some continental Asian species, see below), and the differences in the vesica just represent only a simple reduction of vesica lobes and cornuti for [some of] the Philippine species. Also, the wing pattern, especially the "blind" eyespots on the fw., are very often nearly identical, with a brighter centre and a darker ring on the outside. Especially the HT of *C. halconensis* sp. n. externally rather closely resembles the recently described *C. timorensis* and also some forms of *C. hayatiae* (compare Naumann & Lane 2010: 18).
- There appears to be some similarity (in the valve structure, in the wing pattern, and also to a much smaller degree in the mtDNA barcode) between some of the continental *Cricula* species in Vietnam and China (e.g., *C. hainanensis* Brechlin, 2004, *C. australosinica* Brechlin, 2004 or *C. hoabinhnguyeni* Naumann & Löffler, 2010, which all were placed by Naumann & Löffler 2010: 11 into a new, not yet named species-group), and the *luzonica*-group as defined here, which may give hints about a possible relationship. This unnamed group is not showing up very closely to the *luzonica*-group in the barcode tree of the genus, but this might also be explained by some sort of "structural noise" in the COI-mtDNA produced over long time spans, because this separation event must have taken place very long ago anyway.
- The geological evolution of the Philippines and all other islands in SE Asia during the Cenozoic was very complicated, and there is still no uniform opinion about these processes in tectonic publications. However, there is some probability that parts of the present-day Philippines (especially Mindoro, Calamian and north Palawan) shifted from the Chinese coast near Taiwan through the present South-China sea to the Philippines during the early Cenozoic (Hall 1996). These might have taken their insect fauna from the continent to the present Philippines (while the Lesser Sunda Islands today inhabited by members of the *hayatiae*-subgroup might have been colonized via what is called Sundaland today). However, Hall (1998) interpreted these shifting processes off the continent as having taken place under submersed conditions. The geology of the SE Asian islands is not yet sufficiently known to get unambiguous explanations for distribution patterns based on Cenozoic dispersal events.

The sequence similarity of the mtDNA barcode as expressed in Figs. 1a, 1b may be explained differently:

- For example, the barcode results may not show a real relationship, but just some sort of accidential similarity or so-called long-branch effects, perhaps caused by the long time span involved. Other characters should be studied to solve this basic question.

In case that the barcode results really do express a true phylogenetic relationship:

1. Possibly there may be further members of the group, still unknown, in unexplored mountain chains of Sulawesi or Sundaland or elsewhere, which could close this unexplained gap.
2. The *hayatiae*-subgroup evolved somewhere in the area between (and including) the Philippines and the Lesser Sunda Islands, and further members of the group have lived on islands in between, but became extinct in the meanwhile.
3. The two subgroups (the *luzonica* [*s. str.*]-subgroup on the Philippines and the *hayatiae*-subgroup on the Lesser Sunda Islands) came from a common ancestor (perhaps living on Sundaland or on the Asiatic continent?), which separated relatively early into these two groups and dispersed into two different directions; the species lost any contact relatively early, and there are no remnants left from the common ancestor and intermediate populations (this is a variant of the above hypothesis no. 2, but with even a longer time span involved). This would perhaps best explain the great differences in ♂ genitalia morphology, in case that the barcode results do exhibit true close relationship.

In any case: If the possible phylogenetic relation between the Philippine, the Lesser Sundanian and the continental Asian species can be proven by further characters and studies, there must have been a way how they reached their isolated present-day areas. At present our data base is not broad enough to come to reliable conclusions.

Resulting new checklist of the *luzonica*-group

The *luzonica*-group [*sensu novo et lato*] of the genus *Cricula* comprises the following species and subspecies now (the subgroups each in the arrangement as shown in the barcode similarity tree, see Fig. 1b):

luzonica [*s. str.*]-subgroup:

Cricula halconensis Nässig & Treadaway, 2011 – Mindoro

Cricula kareli Nässig & Treadaway, 1997 – Mindanao

Cricula luzonica Jordan, 1909 – Luzon

Cricula leyteana Nässig & Treadaway, 1997 – Visayas, with the following subspecies:

- *Cricula leyteana leyteana* Nässig & Treadaway, 1997 – Leyte
- *Cricula leyteana bayani* Nässig & Treadaway, 2011 – Panay; Negros?

hayatiae-subgroup:

Cricula timorensis Naumann & Lane, 2010 – Timor

Cricula maxalorensis Naumann & Löffler, 2010 – Alor

Cricula hayatiae Paukstadt & Suhardjono, 1992 – Flores

© Entomologischer Verein Apollo e. V., Frankfurt am Main

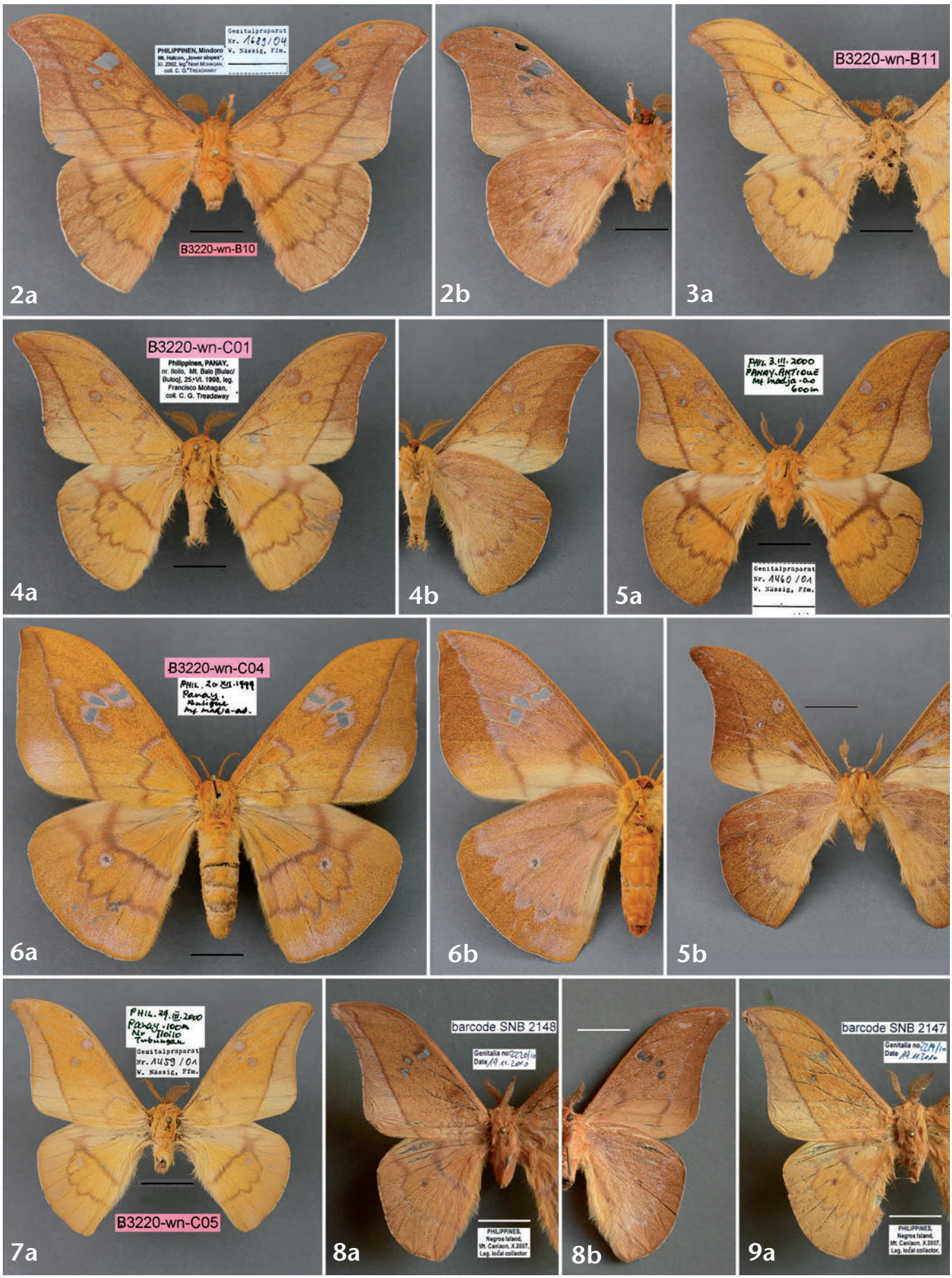


Fig. 2: *Cricula halconensis* sp. n., Mindoro, HT ♂. — **Fig. 3:** *C. kareli,* locality mislabelled ("Mindoro", recte Mindanao; see text), label not shown. — **Figs. 4–7:** *C. leyteana bayani* ssp. n., Panay. **Fig. 4:** HT ♂. **Fig. 5:** PT ♂, dark form. **Fig. 6:** PT ♀, bright form. **Fig. 7:** PT ♂, small bright form. — **Figs. 8–9:** *Cricula leyteana* ssp.?, Negros, CSNB. **Fig. 8:** dark specimen. **Fig. 9:** bright specimen. — Photos W. A. NÄSSIG, except Figs. 8–9 (S. NAUMANN). Specimens approximately natural size; scale bars = 1 cm. Labels not to the same scale, sometimes reduced to greyscale for better legibility. Always **a** = OS, **b** = US of the same specimen.

© Entomologischer Verein Apollo e. V., Frankfurt am Main

Figs. 10–13: Genitalia of the new taxa from the Philippines. — **Fig. 10:** *C. halconensis* sp. n., Mindoro, HT ♂, GP WAN/SMFL 1689/04. — **Figs. 11–12:** *C. leyteana bayani* ssp. n., Panay. **Fig. 11:** ♂ PT, GP WAN/SMFL 1460/01. **Fig. 12:** ♀ PT, GP WAN/SMFL 1461/01. — **Fig. 13:** *C. leyteana* ssp., Negros, GP SNB 2220/10, CSNB. — Scale bars = 1 mm, all approximately to the same scale. Photos WAN.

Diagnostic differences between *C. mindanaensis* (*elaezia*-group) and *C. kareli* (*luzonica*-group) on Mindanao

Sometimes the two species *Cricula mindanaensis* and *C. kareli* can be collected synchronously and syntopically on Mindanao:

C. mindanaensis: 3 ♂♂, 1 ♀, Mt. Dulangdulang, 14./15. XI. 2000, leg. local collector, CCGT in SMFL; collected together with a ♂ of *C. kareli* (i.e., same label data).

Repeatedly we have been asked about external differences between ♂♂ of *C. mindanaensis* and such ♂ forms of *C. kareli* which have multiple (3–5) hyaline windows on their fw. and are additionally dark reddish brown in colouration. (For the reliable and unequivocal differences in genitalia morphology between these two species, see Nässig & Treadaway 1997, 1998.) Such ♂ forms may occur not rare at times in *C. kareli;* we think that the ground colouration and the size of the hyaline fw. spots in many species of the genus *Cricula* (but evidently not in the more or less constantly coloured ♂♂ of *C. mindanaensis*) may at least in part depend on the climatical conditions of the area and weather conditions during development. The maroon ground colour, the colour of pattern details and especially the shape of the L- or crescent-shaped fw. spot (see Nässig et al. 2010: 161, figs. 10–13) in all specimens of *C. mindanaensis* which we have seen is very constant; and no *kareli* specimen seen by us matches exactly the same maroon colour shades of all known ♂♂ of *C. mindanaensis*.

It must be stated again, however, that a safe and reliable determination of *Cricula* species **always** requires at least a dissection of the genitalia! Regular studies of the mtDNA barcode could also be quite helpful for identification, especially of ♀♀, which sometimes may resemble each other between species even more closely.

Acknowledgements

Stefan Naumann, Berlin, kindly allowed to use his barcode sequence data from the BOLD project for our research and searched in his collection for "forgotten" specimens from Negros. He, Swen Löffler, Lichtenstein (Sachsen, Germany), and Steve Kohll, Kayl (Luxembourg), kindly provided a lot of data from material in their collections.

Special thanks are due to Rodolphe Rougerie, now Rouen, and staff members at the Biodiversity Institute of Ontario, University of Guelph, Ontario, Canada, for their work producing the DNA barcodes. The molecular work was funded by NSERC and Genome Canada through a grant to Paul D. N. Hebert.

© Entomologischer Verein Apollo e. V., Frankfurt am Main

References

Brechlin, R. (2004): Drei neue Saturniiden (Lepidoptera) aus China. *Cricula australosinica* n. sp., *Cricula hainanensis* n. sp. und *Loepa sinjaevi* n. sp. – Arthropoda, Magazin über Wirbellose im Terrarium, Wernigerode, **12** (3): 17–25.

—— (2010 [26. i.]): Neue Taxa der Gattung *Cricula* Walker, 1855 (Lepidoptera: Saturniidae). – Entomo-Satsphingia, Pasewalk, **3** (1): 36–44. [Incorrect publication date printed on frontpage: "9. i. 2010", see Nässig at al. 2010.]

Hall, R. (1996): Reconstructing Cenozoic SE Asia. – Pp. 153–184 *in:* Hall, R., & Blundell, D. J. (eds.), Tectonic evolution of Southeast Asia. – Geological Society Special Publication, **106:** XIII + 566 pp. – London (Geol. Soc.).

—— (1998): The plate tectonics of cenozoic SE Asia and the distribution of land an sea. – Pp. 99–131 [with col. pls.] *in:* Hall, R., & Holloway, J. D. (eds.), Biogeography and geological evolution of SE Asia. – Leiden (Backhuys Publ.), [4] + 417 pp.

Nässig, W. A. (1995, unpubl.): Eine Revision der Gattung *Cricula* Walker 1855 sowie ein Versuch einer phylogenetischen Analyse der Tribus Saturniini (Lepidoptera: Saturniidae). – PhD thesis, J. W. Goethe University (Fachbereich Biologie), Frankfurt am Main, 113 pp.

——, Kitching, I. J., Peigler, R. S., & Treadaway, C. G. (2010): The group of *Cricula elaezia:* Comments on synonyms and priority questions, with illustrations of barcode similarity trees, distribution maps, a revised checklist and a formerly unknown female (Lepidoptera: Saturniidae). – Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, N.F. **31** (3): 145–165.

——, & Treadaway, C. G. (1997): Neue Saturniiden von den Philippinen (Lepidoptera). – Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, N.F. **17** (4): 323–366.

——, & —— (1998): The Saturniidae (Lepidoptera) of the Philippines. – Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, **Suppl. 17:** 223–424.

Naumann, S. (2010): Kritische Anmerkungen zu kürzlich publizierten Originalbeschreibungen innerhalb der Familie Saturniidae (Lepidoptera, Saturniidae). – Neue Entomologische Nachrichten, Marktleuthen, **64:** 143–144.

——, & Lane, D. (2010): A new species of the genus *Cricula* Walker, 1855 from East Timor (Lepidoptera: Saturniidae). – Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, N.F. **31** (1/2): 17–19.

——, & Löffler, S. (2010 [19. i.]): Notes on the Asian genus *Cricula* Walker, 1855, with description of new species (Lepidoptera, Saturniidae). – Neue Entomologische Nachrichten, Marktleuthen, **Supplement 2:** 1–24. [Misprinted as "Supplement 1" on the front page.]

——, & Nässig, W. A. (2010): Revisional notes on the species-group of *Saturnia grotei* Moore, 1859 of the genus *Saturnia* Schrank, 1802 (Lepidoptera: Saturniidae). – Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, N.F. **31** (1/2): 31–62.

Paukstadt, U., & Paukstadt, L. H. (1992): Beitrag zur Kenntnis der Färbungs- und Zeichnungsvariabilität von *Cricula hayatiae* U. Paukstadt & Suhardjono 1992 (Lepidoptera: Saturniidae). – Galathea, Berichte des Kreises Nürnberger Entomologen, Nürnberg, **8** (4): 136–140.

——, & —— (1993a): Zur Verbreitung der Gattung *Cricula* Walker 1855 auf den kleinen Sundainseln, Indonesien (Lepidoptera: Saturniidae). – Entomologische Zeitschrift, Essen, **103** (1/2): 19–20.

——, & —— (1993b): Die Präimaginalstadien von *Cricula hayatiae* Paukstadt & Suhardjono 1992 von Flores, Indonesien, sowie Angaben zur Biologie und Ökologie (Lepidoptera: Saturniidae). – Entomologische Zeitschrift, Essen, **103** (23): 429–438.

——, & —— (1995): Kurzbeschreibungen und Farbabbildungen der Raupenstadien einiger wilder Seidenspinner (Lepidoptera: Saturniidae) von den Kleinen Sunda-Inseln und aus Papua Neu Guinea. – Galathea, Berichte des Kreises Nürnberger Entomologen, Nürnberg, **11** (4): 155–164.

——, & —— (2010): Beitrag zur Identität von *Cricula pelengensis* Paukstadt & Paukstadt, 2009 und weiterer Taxa der Gattung *Cricula* Walker, 1855 (Lepidoptera: Saturniidae). – Beiträge zur Kenntnis der wilden Seidenspinner, Wilhelmshaven, **8** (2): 55–64.

——, & Suhardjono, Y. R. (1992): *Cricula hayatiae* n. sp., eine neue Saturniidae (Lepidoptera) von Flores, Indonesien. – Entomologische Zeitschrift, Essen, **102** (14): 253–258.

Ratnasingham, S., & Hebert, P. D. N. (2007): Barcoding. BOLD: The barcode of life data system (www.barcodinglife.org). – Molecular Ecology Notes, Hoboken, **7** (3): 355–364.

Roepke, W. [K. J.] (1940): Aanteekeningen over het geslacht *Cricula* Wlk. (Lep., Saturniidae). – Entomologische Mededeelingen van Nederlandsch-Indië, Buitenzorg (Java), **6** (2): 23–32, pl. 4.

Treadaway, C. G. (1998): Short introduction to Philippine natural and geological history and its relevance for Lepidoptera. – Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, **Suppl. 17:** 7–16.

Vaglia, T., Haxaire, J., Kitching, I. J., Meusnier, I., & Rougerie, R. (2008): Morphology and DNA barcoding reveal three cryptic species within the *Xylophanes neoptolemus* and *loelia* species-groups (Lepidoptera: Sphingidae). – Zootaxa, Auckland, **1923:** 18–36.

Vane-Wright, R. I. (1990): Chapter 2: The Philippines – Key to the biogeography of Wallacea? – Pp. 19–34 *in:* Knight, W. J., & Holloway, J. D. (eds.), Insects and the rain forests of South East Asia (Wallacea). – London (Royal Entomological Society of London), iv + 343 pp.

Internet references

Barcode of Life (bold) (2010): www.barcodinglife.org. – Last accessed: 1. xi. 2010.

CCDB Website (2010): www.dnabarcoding.ca/pa/ge/research/ protocols. – Last accessed: 29. x. 2010.

© Entomologischer Verein Apollo e. V., Frankfurt am Main, Januar 2011 ISSN 0723-9912

© Entomologischer Verein Apollo e. V., Frankfurt am Main